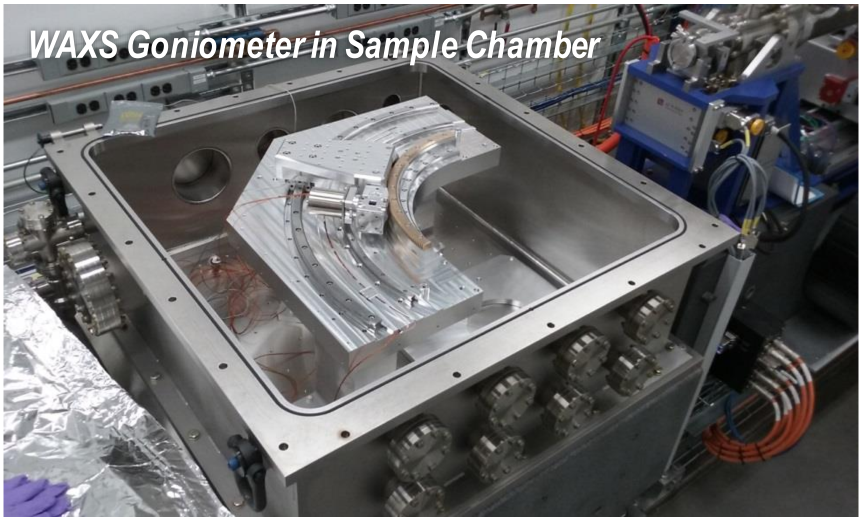
NSLS-II Experimental Tools (NEXT)

June 2016 Project Activity
Report due date: July 20, 2016



SMI endstation components

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OVERALL ASSESSMENT

Final preparations for the ISR and ESM IRRs were completed during June and the IRRs were held on June 28-29. Following closure of any pre-start findings, first light is expected to be taken at these beamlines in July.

Following the resumption of NSLS-II operations on June 3, ISS commissioned focusing mirrors installed during the May maintenance period and aligned the focused beam to the B1 endstation. On June 23, the flux measured in the ISS endstation exceeded the Objective KPP value. ISS commissioning will continue in July, looking forward to first scientific commissioning in August.

PDS installation and testing at SMI and SIX continued in June, working toward IRRs for those two beamlines planned for early November. Radiation shielding analysis is underway for both beamlines, to be completed by September.

Remaining safety system (PPS, EPS) and beamline controls system installation and testing continued in June.

Final preparations for iterative shimming and magnetic measurements of the SIX EPU57 insertion device continued in June. Confirmation that measured field profiles match the prediction for a specific shimming action is key to the success of this process. Using in-house modeling-based (IDBuilder) shimming, we expect to improve the magnetic performance of the SIX EPU57 and ESM EPU105 insertion devices beyond what is capable from current EPU suppliers worldwide.

Two major procurements were completed in June: the ISS High Harmonic Rejection Mirror system and the long-period EPU contract (EPU57 for SIX and EPU105 for ESM). Monitoring and management of contractor progress on the 21 remaining major procurement contracts are important ongoing activities that are crucial to maintaining project schedule. Seven of these contracts are for SIX, 6 are for ISR, 3 for ISS, 2 for SMI, 2 are shared between ESM and SIX, and 1 is for ESM.

As of June 30, 2016, the project is 88.2% complete based on base scope performance earned to date. The cumulative EVMS schedule index rose 0.01 to 0.95, while the cumulative cost index remained at 0.94.

One PCR was approved and implemented in June, a level 3 PCR to implement ESM and SIX contract amendments and updates (+$74k). This PCR increased BAC by $0.07M, to $82.7M. Cost contingency is $7.3M, which is 74.8% of $9.8M BAC work remaining. The EAC, reported as the sum of actual cost to date (ACWP) plus the estimated cost to complete (ETC), is $87.48M, $0.02M lower than the May value. As of the end of June, contingency on EAC is $2.52M, which represents 25.4% of $9.92M EAC work remaining, or 61.6% of $4.08M unobligated work to go ($5.84M of the remaining work is obligated to fixed-price equipment contracts). ETC will continue to be assessed monthly through project completion to understand and contain costs while maintaining the good schedule performance that the project has demonstrated to date.

The project risk registry was updated in June for approval by the NEXT Risk Management Team in July. The updated risk report will be issued in July.

COMMON SYSTEMS

Utilities installation is nearing completion. Other than a few remaining finishing items, electrical utilities scope is complete. On the mechanical utilities side, a greater than expected amount of mechanical utilities effort was provided this month in preparation for the ISR and ESM IRRs. ESM, in particular, needed a significant amount of work in order to integrate and balance the DI water circuits flowing to the water-cooled PDS components. In addition, mechanical utilities installation work in the SIX Satellite Building began in June. This work will finish once the endstation spectrometer is installed later this year.

PPS progress during June included compilation of final documentation in support of the ESM and ISR IRRs. In addition, preliminary installation efforts for the SMI PPS system began. PPS activity at SMI will ramp up in July, as resources role off of other projects. The SMI PPS is expected to be fully certified in October.

The installation, EPICS integration, and final testing of the ISR and ESM photon delivery system EPSs were completed this month, in support of both beamlines' IRRs. At SMI, with EPS requirements now understood, installation is expected to start in August as resources become available.

All remaining control station furniture for ESM and ISR was received this month. The ESM furniture was installed in June, while the ISR furniture is expected to be installed in July, following the June 28-29 IRR. Integration of AC power and network cables for all NEXT control stations is expected to be completed by late summer.

BEAMLINE CONTROLS

Beamline controls activities during June focused on the ESM and ISR beamlines to complete final validation of controls installation and testing for motion, vacuum controls, and beamline diagnostics in preparation for those beamlines' IRRs. The amount of work required is considerable. Following established controls checklists, motion includes limit checks, coordinate system checks, homing testing, full range motion validation, and motion calibration for all axes. Vacuum control and monitoring is provided for all vacuum gauges and ion pump controllers, as well as controls for the Residual Gas Analyzer (RGA) at each beamline, which are set up to run continuous RGA scans. Diagnostics include gigE cameras and the many BPM readouts. All of the beamline controls are implemented with EPICS IOCs, with Operator Interface CSS (Control System Studio), which offers tight integration with history viewing (channel archiver appliance as the back end), and with Operator logbook. The ISR and ESM beamlines both completed their IRRs successfully on June 29 and controls were made ready to take first light in July.

At the SMI beamline, diagnostic camera controls were tested and EPICS control of the Adaptos multi-channel high voltage power supply to be used to adjust the figure of the bi-morph focusing mirrors was developed and tested.

SIX beamline controls installation made good progress in June, with cable pulling and network installation in full swing.

ESM – ELECTRON SPECTRO-MICROSCOPY

ESM installation activities continued at 21-ID during June, in preparation for the IRR scheduled for June 28-29. All photon delivery components of the ARPES branch were installed and tested in advance of the IRR. The only remaining ESM PDS component is the M4 mirror in the XPEEM branch, which is expected to be received in November. Basic installation of the ARPES endstation was also completed in advance of the IRR. Three photos of the ESM beamline ready for its IRR are shown in Figure 1.

The scope of the ESM IRR includes one of the two undulator sources (EPU57), the front end, the photon delivery system (both beamline branches), and the endstation for the ARPES branch.

The large amount of work needing to be accomplished in advance of the IRR made June a particularly hectic month at 21-ID. All groups and staff responsible for IRR preparation, including ESM scientists and engineers and staff from the utility, vacuum, survey, controls, and safety system groups, worked diligently to meet the IRR deadline. One advantage of this situation is that all staff are highly motivated to complete their tasks and a strong sense of cooperation and teamwork naturally is established. By the time of the IRR, all PPS and EPS systems were fully certified, all vacuum sections were baked to reach UHV conditions, all mechanical motions (~70 axes), cameras (~10), and beam current monitors (~15 units) were integrated in the EPICS system and tested, all documentation was prepared, and all travelers were completed.

The IRR was completed successfully on June 29, with one pre-start finding related to insufficient flow in two water circuits which cool the M1 and M2 mirrors. FEA analysis using the actual water flow rates is underway, which we expect will lead to resolution of the water flow issue within a couple of weeks.

ESM looks forward to taking first light in July. This will initiate a period of vacuum conditioning and, in parallel, alignment of the optics to bring focused monochromatic beam to the ARPES endstation. This will enable performance testing, including measurement of flux KPP.

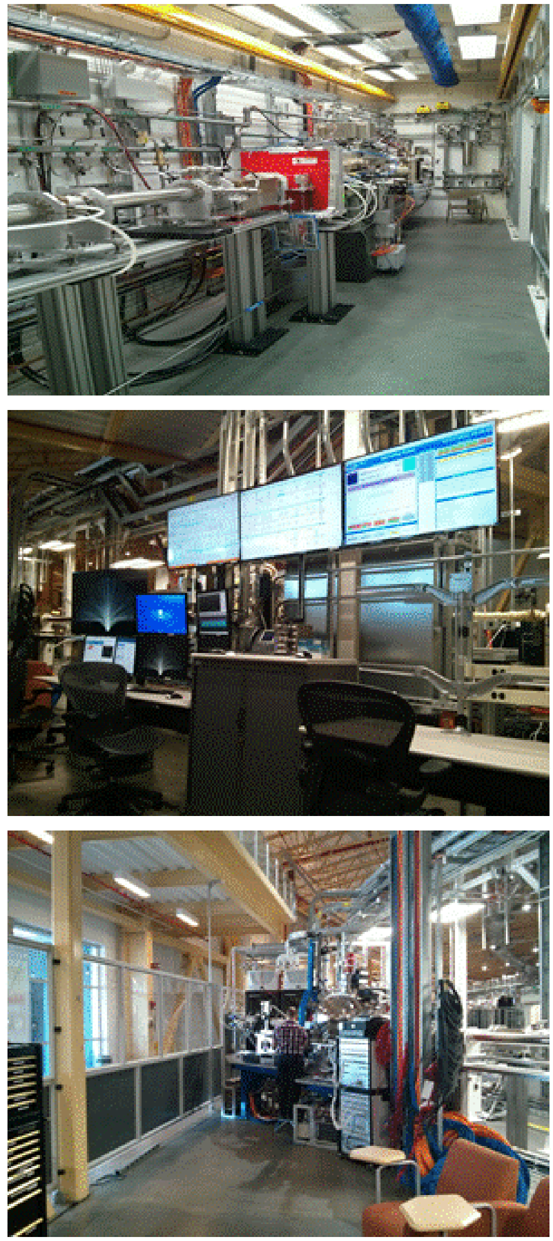


Figure 1. ESM: FOE hutch (top), control station (middle), and ARPES endstation (bottom).

ISR – IN-SITU AND RESONANT HARD X-RAY

Drawings of the synchrotron and bremsstrahlung ray tracing, the secondary bremsstrahlung shield, and the magnet chamber and flange were released. Nine vendor item control drawings— of Optics Package assemblies, the Dual Phase Plate (DPP) Assembly, Shielded Beam Transport System, and the KB Mirrors— and survey data drawings for the SOE optics and vacuum chambers, and for the secondary bremsstrahlung shield, were also released.

Installation and commissioning of the photon delivery system continued in preparation for the June 29 Instrument Readiness Review (IRR). Vacuum work included installation of the DPP ion pumps and the two window gate valves, and bakes of three sections: DPP through BPM2, VFM+VBD2, and BPM3+DHRM. The PPS device was received on June 9, was successfully tested the following day, and was installed in the first vacuum section of the FOE early the next week. The final survey of PDS components was completed on June 17, after which safety-related components were placed under configuration control (see Figure 2). Hutch guillotines and the tops of the lead-shielded ion pump enclosures, which are a part of the Shielded Beam Transport System, were installed on June 21. The water lines for the HFM and its mask were connected to the chiller, and water began circulating on June 22. The Be terminating window was received on June 22 and installed later that week. The cryocooler was successfully started up on June 27, cooling the DCM crystals down to ~85 K. By the end of the day on June 28, the photon delivery system was installed, commissioned, and ready to take beam.

Toyama personnel arrived on June 13 for a 3 week stay to continue installation of the KB Mirrors. The mirrors and bender arrived on June 17, and were delivered to the NSLS-II Metrology Lab for testing that began on June 20. The metrology results were disappointing, with measured slope errors of ~1 μrad, while the specification is ≤0.3 μrad. Metrology is continuing in order to determine the source—mirrors or bender— of the deviations, and possible solutions. Although the bender and mirrors could not be installed during their visit, Toyama personnel did install the vacuum chamber and table in Hutch 4-ID-D and the vacuum chamber was leak-tested and prepared for baking (see Figure 3).

Two NSLS-II reviews were carried out: the Radiation Safety Committee (RSC) review on June 3 and the IRR on June 29. Both went well. There was one recommendation from the RSC review about the need for radiation measurements at the downstream wall of the FOE in order to assess levels and determine if additional posting or area access control is needed, and these measurements will be carried out as a part of the Radiation Survey Plan during beamline commissioning. During the IRR, there was one self-identified post-start— the secondary bremsstrahlung shield has not yet been installed, and it will be required for operations with ring current >400 mA— and no pre-starts. First light is scheduled for July 11.

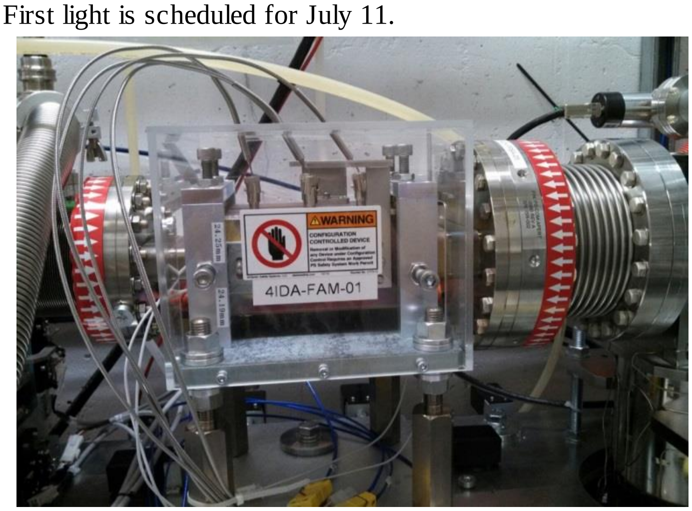


Figure 2. ISR: PPS device and Fixed Aperture Mask (FAM) under configuration control inside the FOE.

Figure 3. ISR: KB Mirrors' vacuum chamber mounted on its table in Hutch 4-ID-D, being prepared for baking.

ISS – INNER SHELL SPECTROSCOPY

During June, the ISS team installed and tested all equipment, controls, and data acquisition software needed to measure the flux KPP, i.e. the photon flux delivered to the sample position. This included PDS commissioning with beam (not part of the NEXT scope) and installation of an ionization chamber system to determine the photon flux.

Using a 160mm-long ionization chamber filled with air and an applied voltage of 1700V, 35μA ionization current was measured. The measurements were performed at a photon energy of 11.5keV, a ring current of 250mA, and a spot size smaller than 1mm^2. The 35μA ionization current is equivalent to a photon flux of 1.25x10^{13} photons/second, which is 25% larger than the scaled objective KPP flux value of 1x10^{13} photons/second at a ring current of 250mA.

The intensity linearity of three different commercially available ionization chambers, using various gas mixtures and high voltage conditions, were tested; none of the chambers showed linear behavior at this photon flux. The typical time response of one of these ionization chambers is shown in Figure 4. The signal in this figure was recorded with an oscilloscope using an amplifier with 1MHz bandwidth and a gain of 10^{5}A/V, resulting in a negative voltage. The baseline of -2.5V corresponds to 25μA ionization current. A pulsed structure with a variation of 0.2V and a periodicity of 2.6μs is visible. For about 2μs the ionization current is 25μA, followed by a gap of about 0.6μs in which the current drops down to 23μA. This pattern is consistent with the ring filling pattern and the periodicity is consistent with the transit time of a single bunch around the ring. The time response of a conventional ionization chamber is determined by the velocity of the generated ions and should not permit observation of these fast variations. Detailed studies revealed that the observed time dependent effect is correlated with the nonlinear behavior of the ionization chamber. At low photon flux values, the timing structure of the ionization chamber response fully disappears.

Also during June, the Factory Acceptance test of the Sample Handling System was conducted successfully at the supplier's (Square One) site. Installation of this contract is expected in July.

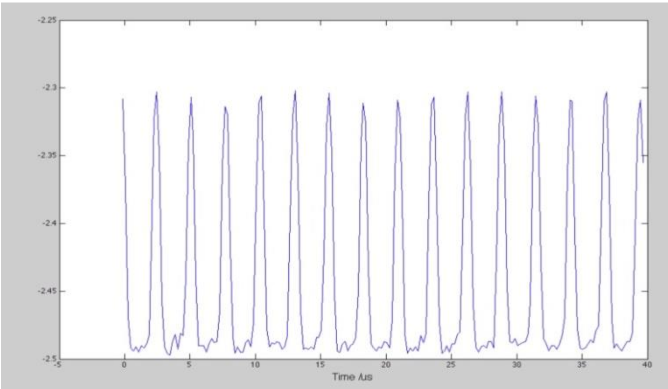


Figure 4. ISS: Measured time response of an ionization chamber located at a sample position in the B1 hutch. Intensity fluctuations with a periodicity of 2.6μs can be observed. Details are explained in the text.

SIX – SOFT INELASTIC X-RAY

Pulling of the vacuum and motion cables in the satellite building continued throughout the month, and is now complete for the photon delivery system, as illustrated in Figure 5. Termination of the motion cables has also begun, as shown in Figure 6. For the endstation cables, a service loop had to be created on top of the racks to allow a patch panel that will interface to cables to be provided by the spectrometer and sample chamber contractor (Bestec) to be positioned on the floor while terminating, prior to elevating it to its final height ~2 m above the floor, adjacent to the sample chamber. Termination of the cables on the patch panel side will take place prior to the delivery of equipment from Bestec in October.

The Utilities group assembled the first portion of the water pressure and temperature stability equipment for M1, M2 and the gratings, on the ratchet wall adjacent to the M1 mirror system (Figure 7). The remainder of this equipment, which consists of thermistors and piping directly bolted to the mirror systems, will be installed by the beamline mechanical technicians in the coming weeks.

The manufacturing of the parts for the sample chamber pedestal and optics wheel by Bestec's subcontractors is complete, and assembly is now underway at Bestec's site as shown in the top panel of Figure 8. Eighteen pieces of granite that will support the spectrometer optics and detector assembly tracks have been shipped from the granite manufacturer in Italy directly to BNL, with an early August delivery. A photo of the granite pieces before shipment is shown in the bottom panel of Figure 8. NEXT Deputy Project Manager Jeff Keister visited Bestec on June 21-22 to view and discuss progress and encourage Bestec to avoid schedule slippage.

Figure 5. SIX: Motion and vacuum cables seen along the cable trays and cable waterfall in the SIX satellite building.

Figure 6. SIX: Motion cables with a service loop routed from above into a controller rack in the SIX satellite building.

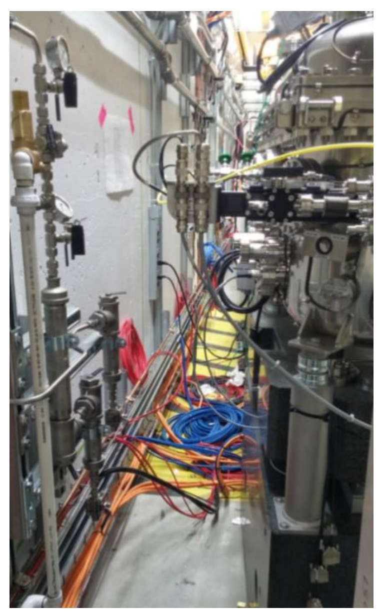


Figure 7. SIX: Water pressure and temperature stability equipment for the M1 mirror system mounted on the ratchet wall.

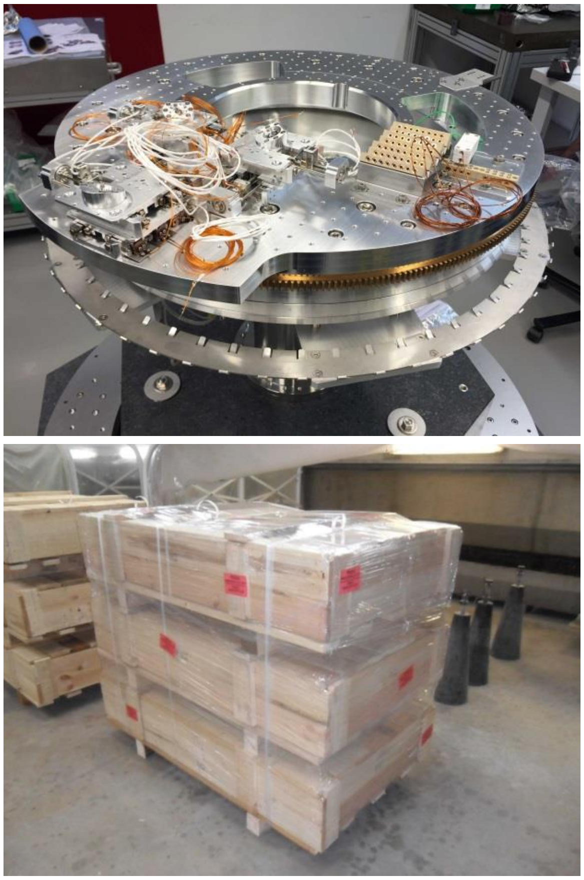


Figure 8. SIX: Sample chamber pedestal and optics wheel during assembly at Bestec (top). Granite blocks for the spectrometer granite tracks at the supplier's site before shipment (bottom).

SMI – SOFT MATTER INTERFACES

Controls implementation and testing progress was made during June on a number of PDS components. First, the majority of the motors of the H-V mirrors system were calibrated and tuned. The high voltage piezo connections to the bi-morph actuators have been validated and await test of the mirror with beam. An EPICS interface to the Adaptos high voltage power supply will be installed and tested in July. Such tools are all-important for SMI's commissioning tasks, which have now been identified in detail and will be important for efficient commissioning with beam.

At the beginning of June, SMI scientists presented the first and second drafts of the SMI Commissioning Plan to the Science Program Management Committee. This plan organized activities on a per-month basis extending from September 2016 to the end of calendar 2018, and includes Photon Delivery System and Low Divergence Time Resolved GISAXS as the first deliverables, followed by WAXS, Microfocus, Tender X-ray, and Liquids capabilities. The plan brings capabilities forward at an aggressive pace, highlighting the many controls tools that will be needed to enable progress.

Customization of NSLS-II Control System Studio (CSS) screens has continued rapid development at SMI. During June, Python code that explicitly determines CRL focusing based on specific lens cartridge loading and position was ported into the CSS framework that reads EPICS PVs corresponding to lens and transfocator stage positions. The screen, shown in Figure 9 at top, takes the beamline energy as input, implements the focal length constraints such as distances to sample and primary mirrors, and allows the user to "poke" lens cartridges in and out, with immediate feedback on where the focal point lands relative to the desired position. Once the lens configuration is optimized, the transfocator Z coordinate can likewise be tweaked until the focus is nominally perfect. This capability is ready for commissioning over the entire SMI X-ray energy range. Work is also well underway for the H-V Mirrors control screen (Figure 9, bottom). Easy to use readouts will allow the users to view and set all degrees of freedom, relating the coordinates to functional states such as whether mirrors are in or out of the beam, and which coated stripe is in the beam path.

June also saw completion of the SMI raytracing. Analysis of monochromatic beam excursions produced by mirror motions shows that the beam always encounters approved shutters and stops. A preliminary raytrace was distributed to the Radiation Safety Committee (RSC), who met with SMI mid-month to discuss SMI raytrace tolerances, progress on the Fluka calculations, and steps to be taken to complete a satisfactory review. The raytracing with cosmetic revisions was submitted shortly after the end of June and will be in checking after mid-July. Along with suggestions for minor additions to the shielding analysis, the RSC confirmed that no further validation of the monochromatic beam components or the 12-ID-B hutch layout, last documented in a 2015 NSLS-II Tech Note, will be required. By the end of June, all components seeing synchrotron white beam and/or primary Bremsstrahlung fan radiation were correctly inserted into the model for the required simulations.

SMI's ambitious plan for X-ray Beam Position Monitors achieved a milestone in June: demonstration of < 10μm thick membranes achieved in electronic grade single crystal diamonds. Figure 10 shows the depth profiles, measured by BNL Instrumentation collaborators, from the wafers most recently shipped from subcontractor DDK. Measurement of the specified 5μm thickness is challenging. Complementary techniques suggest that the membrane thickness is approximately 8μm, which would yield acceptable transmission at 2 keV. Six more devices will be fabricated, and the best three will be installed in the beamline. The team has also performed an X-ray response test, using 11 keV photons at CHESS, on an optical grade diamond. The measurement compared the 30μm diamond response to the response of an 8μm thick region, finding as expected a greater responsivity for the thin membrane due to better photocurrent collection.

SMI is engineering, designing, and fabricating a large number of small custom endstation parts rather than incorporating these in a large contract. Progress is being tracked in detail to maintain schedule. At the end of June, only the SAXS-WAXS mechanics activities still have design details remaining to be resolved, such as motor selection (torque vs. size). It is expected that all requisitions for remaining SMI endstation parts will be completed in July. SAXS and WAXS configuration documents capturing the in-house designed systems, including wiring diagrams and flange layouts, are planned for completion in July.

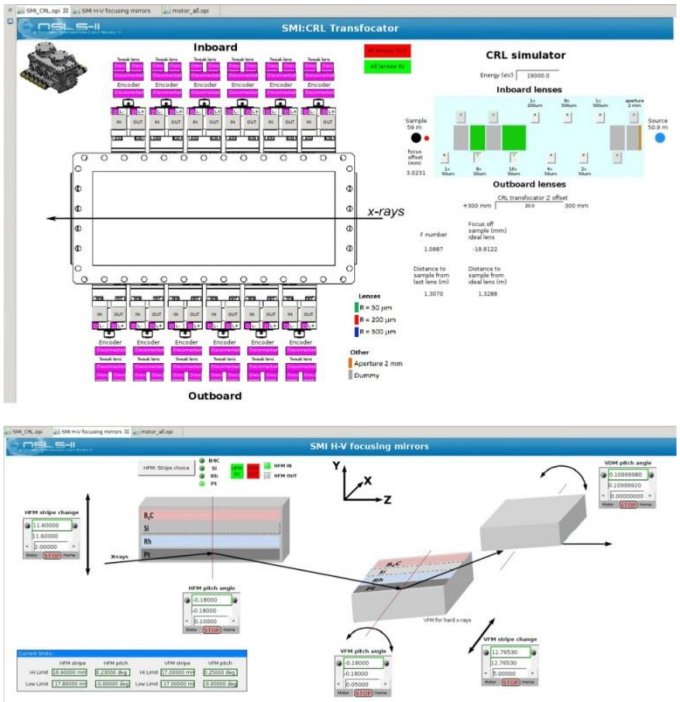


Figure 9. SMI: Top: SMI CSS screen for CRL control. The CRL simulator fields at the right employ Python modules developed by Oleg Chubar and others at NSLS-II to model the explicit design of SMI's transfocator, and give the user feedback relating focus to lens insertion and transfocator position. Bottom: The SMI H-V mirrors screen under development relates motor positions to functional states.

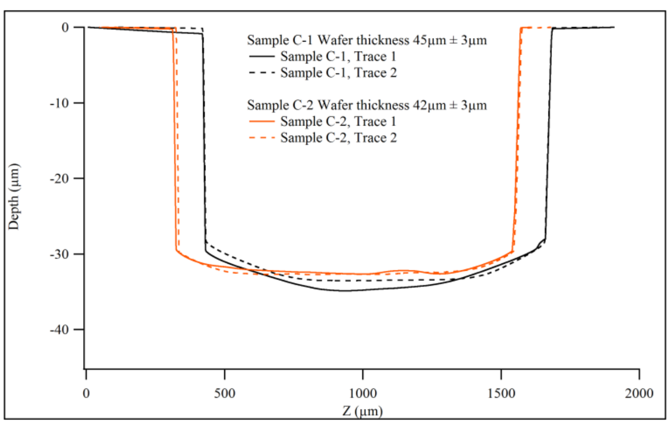


Figure 10. SMI: Measured profiles of SMI etched diamond XBPM wafers, performed by BNL Instrumentation collaborators using a Dektak Stylus Profiler. Initial wafer thickness measurements were assessed redundantly by profilometer and calibrated visual light microscope.

INSERTION DEVICES

The ESM EPU105 insertion device was delivered to BNL on June 1 and unloaded using the same rigging plan as the one developed for SIX EPU57. Data from the Shockwatch logger fixed to the device was retrieved to analyze the temperature, humidity, and acceleration experienced by the ESM EPU105 during shipment. The results indicate smooth transport of the device (Figure 11).

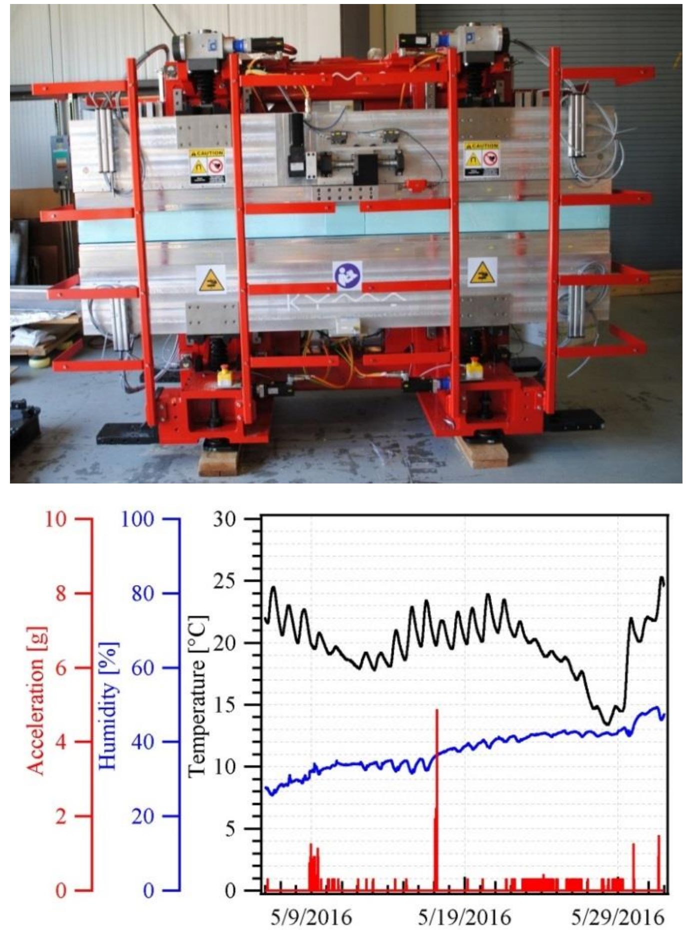


Figure 11. Insertion Devices: Top: The ESM EPU105 insertion device after arrival in Bldg 832. Bottom: Acceleration (red), humidity (blue), and temperature (black) traces recorded by the Shockwatch logger during shipment. The large acceleration recorded on May 18 was a test performed by the EPU supplier (Kyma) upon the receipt of the logger.

Shortly after the delivery of the ESM EPU105 device, a week of training with the contractor was held at BNL. Training was provided to the NSLS-II ID group technicians for standard procedures to be executed over the lifespan of the device. These procedures range from assembly of the magnetic array in the magnetic measurements lab to adjustment of gap protection switches in the insertion device straight section of the NSLS-II accelerator tunnel.

The NSLS-II ID group began magnetic tuning of the SIX EPU57 during June. Two methods of tuning are utilized: (1) horizontal and vertical displacements of magnets within the magnet array, called virtual shimming, and (2) the addition of small magnets, known as magic fingers, at both ends of the device. The software IDBuilder is used to determine the location and the amplitude of adjustments made for both types of tuning. Before beginning the actual tuning, agreement between IDBuilder predictions and magnetic measurements must be confirmed. Figure 12 shows that good agreement was achieved. Achieving this agreement required mechanical slowdown of the measurement (by about a factor of six compared to standard measurement speeds), to minimize hysteresis effects.

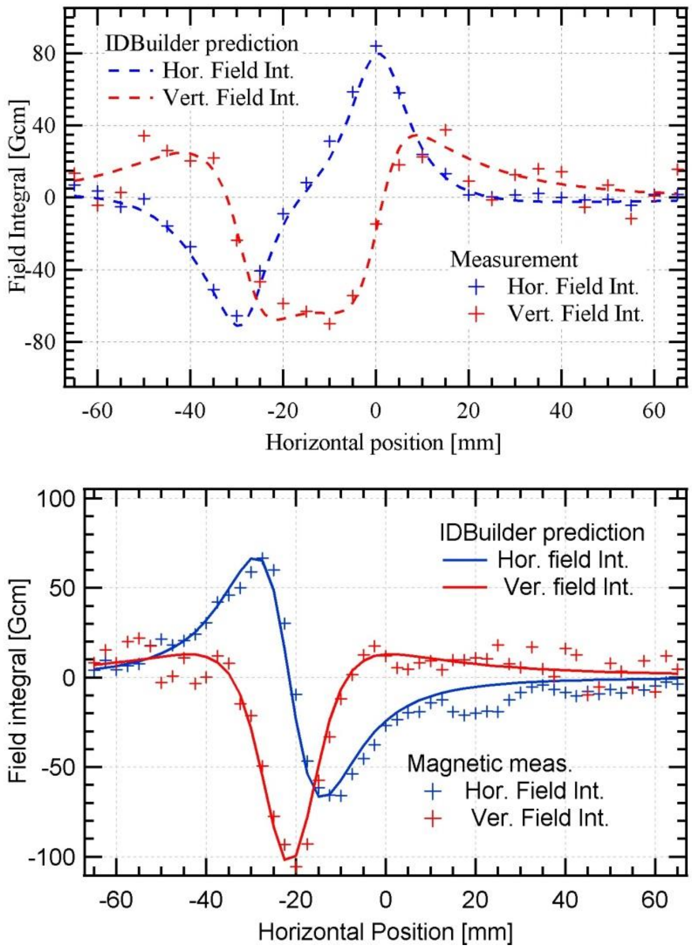


Figure 12. Insertion Devices: Comparison of measured and predicted field integrals introduced by virtual shimming (top) and magic fingers (bottom).

Following confirmation that the measurement and prediction systems were well matched, two iterations of virtual shimming were performed during June. For each iteration, the numbers of magnets to be moved was limited to 6 while IDBuilder optimized the correction of multiple magnetic parameters computed from measured local magnetic field and magnetic field integrals. The optimization parameters are listed in the table below, along with the parameter values before and after correction. The magnetic field integrals before and after correction are shown in the top portion of Figure 13. The bottom portion of Figure 13 shows calculated single electron emission at ~700 eV, comparing the as-delivered and virtually shimmed performance with that of a perfect undulator.

On June 28, the ID group reported that calculations of the angular intensity expected from the SIX EPU57 insertion device at 1 keV photon energy, based on their magnetic measurements, exceeds the objective KPP value of 8×10^{17} photons/sec/0.1% bw/mrad^2 at 500 mA ring current. This significant result speaks to the magnetic performance of this ID, even prior to completion of final magnetic tuning.

A few more tuning iterations are required in order for the SIX EPU57 to meet all NSLS-II magnetic performance requirements.

	Before	After
Total Fitness	10.92	8.16
Radiation Phase Error	3.44	1.97
Horizontal Field Integral	16.84	12.01
Vertical Field Integral	45.02	32.18
Horizontal Field Integral Variation	0.96	0.69
Vertical Field Integral Variation	1.56	1.12
Skew Quad	12.43	8.82
Normal Quad	6.96	10.77
Skew Quad Variation	0.38	0.71
Normal Quad Variation	0.90	0.63
Horizontal Trajectory Straightness	2.13	0.93
Vertical Trajectory Straightness	2.17	2.17
Horizontal Trajectory Offset (Vert. 2nd Field Int.)	4.19	1.59
Vertical Trajectory Offset (Hor. 2nd Field Int.)	3.77	2.66

Table: Insertion Devices: "Fitness" parameters used in IDBuilder to optimize the undulator performance. In each simulation each parameters can be weighted to improve further given parameters.

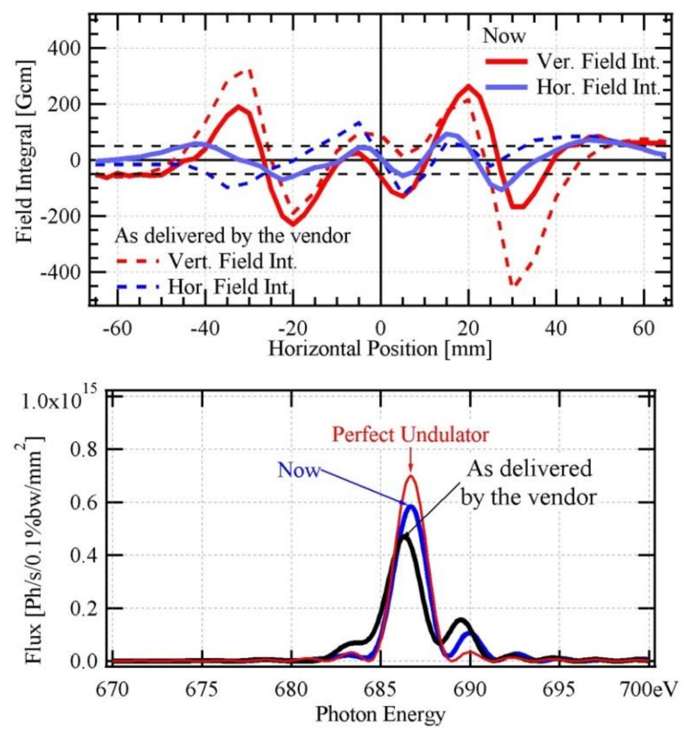


Figure 13. Insertion Devices: Comparison of magnetic field integrals (top) and calculated single electron emission at 686eV (bottom), from the as-delivered device and after two iterations of virtual shimming.

PROJECT MILESTONES

Milestone	Planned	Actual
CD-0 (Mission Need):	May 27, 2010	May 27, 2010
CD-1 (Alternative Selection):	Sept. 30, 2011	Dec. 19, 2011
CD-2 (Performance Baseline):	Dec. 31, 2013	Oct. 9, 2013
CD-3A (Long Lead Procurement):	Dec. 31, 2013	Oct. 9, 2013
CD-3 (Start Construction):	Mar. 31, 2014	Jul. 7, 2014
Early Project Completion:	Jan. 31, 2017	
CD-4 (Project Completion):	Sept. 29, 2017	

RECENT AND UPCOMING EVENTS

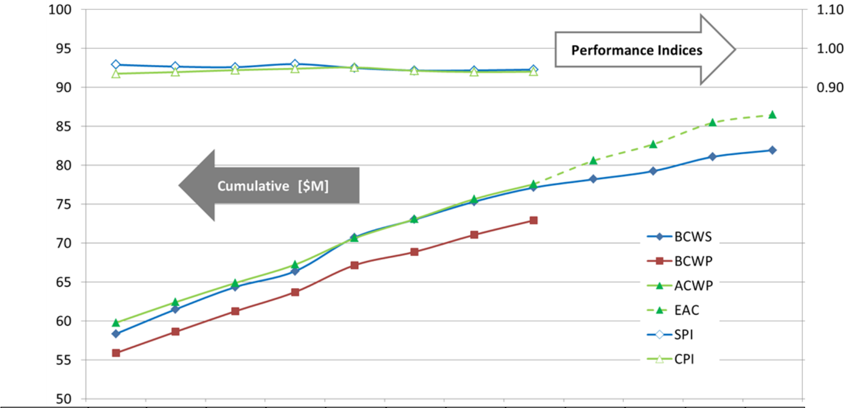
DOE OPA Status Review of NEXT	August 30-31, 2016
DOE OPA EVMS Review (BNL)	October 4-5, 2016

Acronyms and Abbreviations

AC	Alternating Current
ACWP	Actual Cost of Work Performed
ARPES	Angle-Resolved PhotoElectron Spectroscopy
BAC	Budget at Completion
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
BDN	Beamlines Developed by NSLS-II
BNL	Brookhaven National Laboratory
BPM	Beam Position Monitor
BSA	Brookhaven Science Associates
CAM	Cost Account Manager
CD	Critical Decision
CHESS	Cornell High Energy Synchrotron Source
CPI	Cost Performance Index
CRL	Compound Refrative Lens
CSS	Control System Studio
CV	Cost Variance
DCM	Double Crystal Monochromator
DI	De-Ionized
DOE	Department of Energy
DHRM	Double Harmonic Rejection Mirror
DPP	Dual Phase Plate
EAC	Estimate At Completion
EPICS	Experimental Physics and Industrial Control System
EPS	Equipment Protection System
EPU	Elliptically Polarizing Undulator
ES&H	Environment, Safety & Health
ESM	Electron Spectro-Microscopy beamline
ETC	Estimated Cost to Complete
EVMS	Earned Value Management System
FAT	Factory Acceptance Test
FDR	Final Design Review
FE	Front End
FEA	Finite Element Analysis
FOE	First Optics Enclosure
FPGA	Field-Programmable Gate Array
FTE	Full Time Equivalent
FXI	Full-field X-ray Imaging beamline
FY	Fiscal Year
GISAXS	Grazing Incidence SAXS
HFM	Horizontal Focusing Mirror
H-V	Horizontal - Vertical
ID	Insertion Device
IOC	Input / Output Controller
IRR	Instrument Readiness Review
ISR	Integrated In-Situ and Resonant X-ray Studies
ISS	Inner Shell Spectroscopy beamline
IVU	In-Vacuum Undulator
KB	Kirkpatrick Baez
KPP	Key Performance Parameter
M&S	Material & Supplies
NEXT	NSLS-II Experimental Tools project
NSLS	National Synchrotron Light Source
NSLS-II	National Synchrotron Light Source II
OPA	Office of Project Assessment
OPC	Other Project Costs
PCR	Project Change Request
PDS	Photon Delivery System
PEMP	Performance Evaluation and Measurement Plan
PMB	Performance Management Baseline
PPS	Personnel Protection System
RSC	Radiation Safety Committee
SAXS	Small Angle X-ray Scattering
SC	Office of Science
SIX	Soft Inelastic X-ray Scattering beamline
SMI	Soft Matter Interfaces beamline
SOE	Secondary Optics Enclosure
SPI	Schedule Performance Index
SSA	Secondary Source Aperture
SV	Schedule Variance
TEC	Total Estimated Cost
TPC	Total Project Cost
UB	Undistributed Budget
UHV	Ultra-High Vacuum
VAC	Variance At Completion
VBD	Visual Beam Diagnostic
VFM	Vertical Focusing Mirror
WAXS	Wide Angle X-ray Scattering
WBS	Work Breakdown Structure
WS	Working Schedule
XBPM	X-ray Beam Position Monitor
XPEEM	X-ray PhotoEmission Electron Microscopy

COST AND SCHEDULE STATUS

Cost and schedule progress is being tracked using an Earned Value Management System (EVMS) against the cost and schedule baseline established on October 1, 2013. All baseline changes are being controlled through the NEXT Change Control Board. Cost and schedule revisions are being managed using Project Change Control procedures. From June 2015 forward, EAC is reported as the sum of actual cost to date (ACWP) plus the estimated cost to complete (ETC), at the individual activity and resource level, with account-level cost corrections applied as needed to account for the difference between the Earned Value and accrual schedules. ETC values are shown in the final row of the EVMS table below, and all EAC changes are captured in the monthly EAC log.



Cum $M	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16
BCWS	58.3	61.5	64.3	66.4	70.7	73.0	75.3	77.1	78.2	79.2	81.1	81.9
BCWP	55.9	58.6	61.2	63.7	67.2	68.9	71.0	72.9				
ACWP	59.8	62.4	64.9	67.2	70.6	73.1	75.6	77.6				
SPI	0.96	0.95	0.95	0.96	0.95	0.94	0.94	0.95				
CPI	0.93	0.94	0.94	0.95	0.95	0.94	0.94	0.94				
ETC									9.9	6.9	4.8	2.0

NEXT as of 6/30/2016	Current Period	Cum-to-Date
Plan (BCWS) $k	1,808	77,116
Earned (BCWP) $k	1,864	72,905
Actual (ACWP) $k	1,915	77,557
SV $k	56	-4,211
CV $k	-51	-4,652
SPI	1.03	0.95
CPI	0.97	0.94
Budget at Completion $k (PMB [UB])		82,685
Planned % Complete (BCWS/BAC)		93.3%
Earned % Complete (BCWP/BAC)		88.2%
Contingency $k		7,315
Contingency / (BAC – BCWP)		74.8%
EAC $k		87,482
Contingency / (EAC – BCWP)		50.2%
(Contingency + VAC) / (EAC – ACWP)		25.4%
TPC = PMB + Contingency		90,000

The NEXT project Schedule Variance (SV) for June 2016 is +$56k, with an associated monthly Schedule Performance Index (SPI) of 1.03 (green status). The largest contributors to the current month schedule variance are provided in the table below. The cumulative SPI is 0.95 (green status), 0.01 higher than it was in May.

The NEXT project Cost Variance (CV) for June 2016 is -$51k, with an associated monthly Cost Performance Index (CPI) of 0.97 (green status). The primary contributors to the current month CV are provided in the table below. The cumulative CPI is 0.94 (green status), the same as it was in May.

Leading Current Month Variances [$k], June 2016								
WBS	Title	PV	EV	AC	Schedule		Cost	
					SV	Issues	CV	Issues
2.01	Project Support	176	176	185	0	--	-9	--
2.03	Common Systems	315	210	154	-105	Utilities (2.03.01): +$38k; PPS (2.03.02): -$167k (delays as PEMP notable & partner beamlines have taken priority); EPS (2.03.03): +$5k; Control Station (2.03.04): +$18k	56	Driven by good labor efficiency in PPS (WBS 2.03.02, +$28k) and Control Station (WBS 2.03.04, +$22k)
2.04	Controls	117	101	89	-16	--	12	--
2.05	ESM Beamline	38	212	199	175	Completion of PDS installation work scheduled earlier: white & pink beam masks (+$127k), Bremsstrahlung scatter collimator and shield wall (+$17k), cold aperture & differential pump (+$3k), beam pipes (+$5k), non-optics test & commissioning activities (+$5k), diagnostic units (+$8k), and gas cell (+$3k)	13	-
2.07	ISR Beamline	177	421	414	244	Completion of commissioning activities in the FOE Optics Package, which were scheduled for prior months	7	--

Leading Current Month Variances [$k], June 2016								
WBS	Title	PV	EV	AC	Schedule		Cost	
					SV	Issues	CV	Issues
2.08	ISS Beamline	299	166	215	-133	Sum of current period activities, most performed earlier: Sample Handling System activities (-$9k), Focusing Mirror commissioning activities (-$7k), Lens package fabrication activities (-$118k), spectrometer activities (-$41k), Sample Chamber activities (+$45k), FPGA activities (+$6k), and testing activities (-$14k)	-49	Driven by overage in ISS Beamline Systems (WBS 2.08.02), -$49k: M&S CV -$34k: Material payments for the month include $26k for HRM crystals, $10k for FPGA parts, and $5k for vacuum hardware; Labor CV -$15k: Labor costs mostly scientist (~1.5 mFTE) and tech (~0.6 mFTE)
2.09	SIX Beamline	327	112	141	-214	Sum of activities scheduled in June but not performed yet [spectrometer FAT (-$84k), spectrometer packaging and delivery (-$57k), cryostat and braids delivery (-$133k)] and activities performed in June but scheduled earlier [procurement support (+$60k)].	-28	Driven by overage in SIX Beamline Systems (WBS 2.09.02) -$32k: M&S CV -$19k: Material payments for the month include $26k for vacuum hardware, $3k for baking equipment, and $3k for furniture; Labor CV -$13k: labor costs mostly scientist (~2.7 mFTE) and engineer (~1.4 mFTE)
2.10	SMI Beamline	140	130	146	-9	--	-15	--
2.11	Insertion Devices	219	334	372	115	Sum of contributions, some with positive effect and some negative: ESM EPU57 activities scheduled this month but performed earlier (-$47k), training activities performed this month (+$94k), ESM EPU105 activities (+$83k), and activities related to current strip power supplies (-$19k).	-38	Payment for SIX EPU 57 receipt, including accrual catch-up -$89k, plus +$33k (material) and +$19k (labor) cost under-run for the month.
	Total	**1808**	**1864**	**1915**	**56**	**Total**	**-51**	

As of June 30, 2016, the project is 88.2% complete with 74.8% contingency ($7.3M) for $9.8M Budget At Completion (BAC) work remaining, based on PCRs processed and approved through June 2016. The project EAC for June is reported at $87,482k against a Performance Measurement Baseline (PMB)/Undistributed Budget (UB) of $82,685k. The Variance At Completion (VAC) is given by VAC = BAC – EAC, with EAC = ACWP + ETC. Through June 2016, the VAC (-$4,797k) is dominated by the cumulative cost variance (-$4,652k), which is in turn dominated by labor cost overage on work performed to date.

The June 2016 EAC ($87.48M) is $0.02M lower than the May value. As of the end of June, contingency on EAC is $2.52M, which represents 25.4% of $9.92M EAC work remaining. Outstanding commitments on fixed-price equipment contracts total $5.84M, so the $2.52M contingency on EAC represents 61.6% of $4.08M unobligated EAC work to go. ETC will continue to be assessed monthly through project completion to contain costs while maintaining the good schedule performance that the project has demonstrated to date.

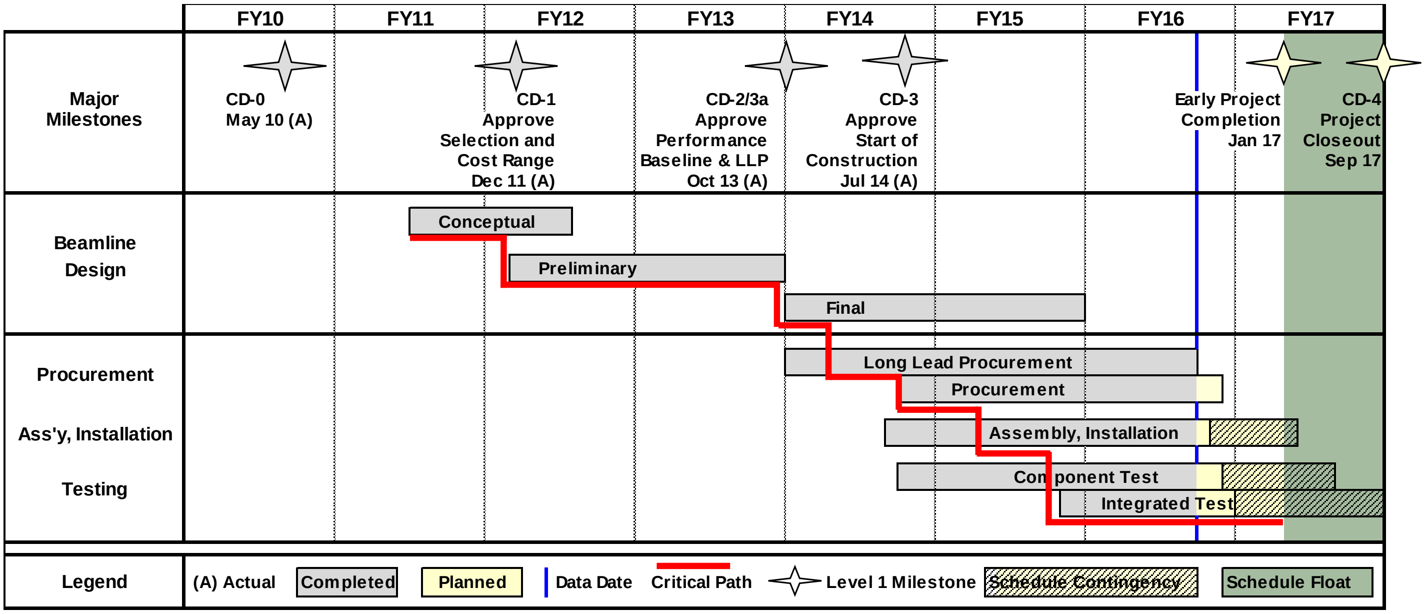
One PCR was approved and implemented in June.

PCR	PCR Level	Baseline Change [$]	Description
PCR-16-118	L3	74	ESM & SIX Contract Amendments & Updates

Three PCRs are planned for July, all Level 3 PCRs to incorporate EAC changes in base scope: PCR_16_119 affects WBS 2.03 (Common Systems), PCR_16_120 affects WBS 2.04 (Beamline Controls) and WBS 2.11 (Insertion Devices), and PCR_16_121 affects WBS 2.07 (ISR Beamline) and WBS 2.10 (SMI Beamline).

Milestones – Near Term		Planned	Actual
L3	SIX - Testing Monochromator and Slits complete	1-Mar-16	Expect August
L3	ISR - Installation of DCM Monochromator complete	15-Mar-16	24-Jun-16
L3	Common Beamline Systems: Electrical Utilities Installed	29-Apr-16	27-May-16
L3	ESM - Testing Monochromator and Slits complete	12-May-16	27-May-16
L2, L3	Common Beamline Systems: Mechanical Utilities Installed	31-May-16	Expect August
L3	ISR – Installation of Beamline Components Complete	29-Jun-16	Expect December
L2	Receive EPUs for ESM and SIX	12-Aug-16	1-Jun-16
L3	Insertion Devices - ESM EPU105 Received	12-Aug-16	1-Jun-16
L3	SIX - Testing of Spectrometer Detector Complete	23-Aug-16	Expect September
L3	WBS 2.04 – Beamline Control Systems Complete	14-Sep-16	Expect December
L3	SMI – Installation of Beamline Components Complete	16-Sep-16	Expect December
L3	ESM – Installation of Beamline Components Complete	29-Sep-16	Expect November
L3	SIX – Installation of Beamline Components Complete	30-Sep-16	Expect December
L3	Common Beamline Systems: EPS Installed	30-Sep-16	Expect December
L2, L3	Complete Installation of Common Beamline Systems PPS	30-Sep-16	Expect December
L2	Early Project Completion – incl. IRR	31-Jan-17	Expect January

PROJECT SCHEDULE



As of June 2016, the critical path runs through PPS design, software development, testing, and integration for the SIX beamline (WBS 2.03.02, Common Systems PPS).

Staffing Report

Staffing as of 6/30/2016	Current Period		Cumulative-to-Date	
	Planned ** (FTE-yr)	Actual (FTE-yr)	Planned ** (FTE-yr)	Actual (FTE-yr)
WBS 2.01 Project Management and Support	0.79	0.53	37.32	34.00
WBS 2.02 Conceptual and Advanced Conceptual Design	0.00	0.00	8.74	8.74
WBS 2.03 Common Beamline Systems	1.33	0.74	27.96	15.23
WBS 2.04 Control System	0.48	0.48	19.86	18.36
WBS 2.05 ESM Beamline	0.42	0.92	15.41	17.47
WBS 2.06 FXI Beamline	0.00	0.00	4.77	4.60
WBS 2.07 ISR Beamline	0.63	0.75	15.75	14.42
WBS 2.08 ISS Beamline	0.09	0.19	14.05	14.20
WBS 2.09 SIX Beamline	0.55	0.44	17.75	20.47
WBS 2.10 SMI Beamline	0.27	0.44	14.28	13.94
WBS 2.11 Insertion Devices	0.93	0.47	5.88	5.36
WBS 2.12 ID & FE Installation	0.00	0.00	3.88	7.97
Total	**5.50**	**4.96**	**185.64**	**174.76**

** Based on the NEXT working schedule

* A large fraction of utilities installation has been performed by contractors (M&S) rather than staff as originally planned

Number of individuals who worked on NEXT during June 2016: 136

Funding Profile

Funding Type	NEXT Funding Profile ($M)						
	FY11	FY12	FY13	FY14	FY15	FY16	Total
OPC	3.0						3.0
TEC – Design		3.0	2.0				5.0
TEC – Fabrication		9.0	10.0	25.0	22.5	15.5	82.0
Total Project Cost	**3.0**	**12.0**	**12.0**	**25.0**	**22.5**	**15.5**	**90.0**

Key NEXT Personnel

Title	Name	Email	Phone
Federal Project Director	Robert Caradonna	rcaradonna@bnl.gov	631-344-2945
NEXT Project Manager	Steve Hulbert	hulbert@bnl.gov	631-344-7570

COST PERFORMANCE REPORT

CONTRACT PERFORMANCE REPORT

FORMAT 1 - WORK BREAKDOWN STRUCTURE

$ | FORM APPROVED | OMB No. 0704-0188

1. CONTRACTOR	2. CONTRACT	3. PROGRAM	4. REPORT PERIOD
a. NAME Brookhaven National Laboratory	a. NAME NEXT	a. NAME NSLS-II Experimental Tools (NEXT) Project	a. FROM *(YYYYMMDD)* 2016 / 06 / 01
b. LOCATION (Address and ZIP Code)	b. NUMBER	b. PHASE	b. TO *(YYYYMMDD)* 2016 / 06 / 30
	c. TYPE / d. SHARE RATIO	c. EVMS ACCEPTANCE X YES	

WBS (2) / WBS (3) / ITEM	CURRENT PERIOD: BUDGETED COST: WORK SCHEDULED	CURRENT PERIOD: BUDGETED COST: WORK PERFORMED	CURRENT PERIOD: ACTUAL COST WORK PERFORMED	CURRENT PERIOD: VARIANCE: SCHEDULE	CURRENT PERIOD: VARIANCE: COST	CUMULATIVE TO DATE: BUDGETED COST: WORK SCHEDULED	CUMULATIVE TO DATE: BUDGETED COST: WORK PERFORMED	CUMULATIVE TO DATE: ACTUAL COST WORK PERFORMED	CUMULATIVE TO DATE: VARIANCE: SCHEDULE	CUMULATIVE TO DATE: VARIANCE: COST	AT COMPLETION: BUDGETED	AT COMPLETION: ESTIMATED	AT COMPLETION: VARIANCE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(14)	(15)	(16)
2.01 Project Management and Support	176,369	176,369	185,234	0	(8,865)	8,731,302	8,731,302	9,532,697	0	(801,395)	9,918,232	10,672,007	(753,774)
2.01.01 Project Management	75,453	75,453	61,933	0	13,520	4,082,714	4,082,714	3,800,490	0	282,224	4,598,029	4,364,304	233,724
2.01.02 Project Support	100,916	100,916	123,301	0	(22,385)	4,648,587	4,648,587	5,732,207	0	(1,083,619)	5,320,204	6,307,703	(987,499)
2.02 Conceptual Design and Advanced Conceptual Design	0	0	0	0	0	1,807,316	1,807,316	1,807,316	0	0	1,807,316	1,807,316	0
2.03 Common Beamline Systems	315,287	210,303	153,870	(104,984)	56,433	6,881,984	6,411,370	7,760,040	(470,614)	(1,348,670)	7,266,877	8,681,423	(1,414,546)
2.03.01 Utilities	0	38,407	50,504	38,407	(12,097)	4,209,423	4,055,519	4,309,000	(153,904)	(253,482)	4,209,423	4,540,292	(330,870)
2.03.02 Personnel Protection System (PPS)	235,733	68,496	40,445	(167,238)	28,051	1,368,257	1,068,365	1,887,325	(299,893)	(818,960)	1,547,893	2,400,820	(852,927)
2.03.03 Equipment Protection System (EPS)	42,550	47,975	33,166	5,425	14,809	530,965	567,177	831,122	36,212	(263,945)	680,294	898,454	(218,160)
2.03.04 Control Station	24,580	43,001	21,487	18,422	21,514	304,167	251,138	170,509	(53,029)	80,629	306,744	226,167	80,577
2.03.05 Common Beamline Systems Management	12,423	12,423	8,268	0	4,155	469,171	469,171	562,083	0	(92,912)	522,524	615,690	(93,166)
2.04 Control System	117,475	101,032	88,593	(16,443)	12,439	4,345,521	4,339,288	4,493,292	(6,233)	(154,005)	4,558,236	4,805,538	(247,302)
2.04.01 Control System Management	5,200	5,200	2,300	0	2,900	268,569	268,569	241,252	0	27,317	294,427	266,999	27,428
2.04.02 Control System Design & Implementation	112,275	95,832	73,666	(16,443)	22,166	2,726,728	2,720,496	2,952,397	(6,233)	(231,902)	2,913,586	3,164,015	(250,429)
2.04.03 Control System Equipment	0	0	12,627	0	(12,627)	1,350,223	1,350,223	1,299,644	0	50,580	1,350,223	1,374,524	(24,300)
2.05 ESM Beamline	37,753	212,312	199,332	174,559	12,979	9,287,255	9,078,370	9,684,196	(208,885)	(605,826)	9,422,464	10,006,761	(584,297)
2.05.01 ESM Management	14,244	21,866	6,385	7,622	15,481	551,769	559,392	466,315	7,622	93,076	610,744	518,891	91,853
2.05.02 ESM Beamline Systems	23,509	190,446	192,948	166,937	(2,502)	8,735,485	8,518,978	9,217,881	(216,507)	(698,903)	8,811,720	9,487,869	(676,150)
2.06 FXI Beamline	0	0	0	0	0	1,818,324	1,818,324	1,793,425	0	24,899	1,818,324	1,793,425	24,899
2.06.01 FXI Management	0	0	0	0	0	409,359	409,359	470,908	0	(61,549)	409,359	470,908	(61,549)
2.06.02 FXI Beamline Systems	0	0	0	0	0	1,408,965	1,408,965	1,322,516	0	86,448	1,408,965	1,322,516	86,448
2.07 ISR Beamline	176,783	420,706	413,693	243,923	7,013	9,537,025	8,552,365	8,743,286	(984,660)	(190,921)	10,361,410	10,603,386	(241,976)
2.07.01 ISR Management	30,375	46,010	31,718	15,635	14,292	982,251	997,887	976,313	15,635	21,573	1,105,394	1,055,654	49,741
2.07.02 ISR Beamline Systems	146,409	374,697	381,975	228,288	(7,279)	8,554,774	7,554,479	7,766,973	(1,000,295)	(212,494)	9,256,015	9,547,732	(291,717)
2.08 ISS Beamline	298,857	166,078	215,182	(132,779)	(49,104)	10,231,185	9,860,735	10,669,163	(370,450)	(808,428)	10,472,212	11,197,861	(725,649)
2.08.01 ISS Management	13,543	13,543	13,243	0	300	661,779	789,187	645,199	127,408	143,988	838,199	658,733	179,466
2.08.02 ISS Beamline Systems	285,314	152,535	201,939	(132,779)	(49,405)	9,569,406	9,071,548	10,023,965	(497,858)	(952,417)	9,634,013	10,539,128	(905,115)
2.09 SIX Beamline	326,723	112,472	140,661	(214,251)	(28,190)	9,731,735	8,309,369	8,978,686	(1,422,366)	(669,316)	11,764,836	12,659,823	(894,987)
2.09.01 SIX Management	19,091	19,091	15,523	0	3,568	652,488	652,488	642,124	0	10,364	729,841	719,071	10,770
2.09.02 SIX Beamline Systems	307,632	93,381	125,138	(214,251)	(31,757)	9,079,247	7,656,881	8,336,562	(1,422,366)	(679,681)	11,034,995	11,940,752	(905,758)
2.10 SMI Beamline	139,894	130,440	145,854	(9,454)	(15,414)	8,746,327	8,189,062	8,422,694	(557,265)	(233,632)	9,108,910	9,221,920	(113,010)
2.10.01 SMI Management	11,789	11,789	8,823	0	2,966	694,619	694,619	619,481	0	75,138	802,179	730,398	71,781
2.10.02 SMI Beamline Systems	128,104	118,651	137,031	(9,454)	(18,380)	8,051,708	7,494,443	7,803,213	(557,265)	(308,770)	8,306,731	8,491,522	(184,791)
2.11 Insertion Devices	219,329	334,420	372,214	115,091	(37,794)	4,545,421	4,355,059	4,219,699	(190,362)	135,360	4,733,509	4,579,628	153,881
2.11.01 ESM EPU Insertion Device	216,629	331,720	369,383	115,091	(37,663)	4,344,306	4,153,944	4,069,017	(190,362)	84,927	4,515,912	4,412,521	103,391
2.11.02 SIX EPU Insertion Device	0	0	0	0	0	117,137	117,137	70,375	0	46,762	117,137	70,375	46,762
2.11.03 Insertion Devices Management	2,700	2,700	2,831	0	(131)	83,978	83,978	80,308	0	3,670	100,460	96,733	3,728
2.12 ID & FE Installation & Testing	0	0	0	0	0	1,452,816	1,452,816	1,452,960	0	(143)	1,452,816	1,452,960	(143)
2.12.01 ID & FE Installation & Testing Management	0	0	0	0	0	20,739	20,739	20,739	0	0	20,739	20,739	0
2.12.02 ID Installation & Testing	0	0	0	0	0	584,560	584,560	584,560	0	(0)	584,560	584,560	(0)
2.12.03 FE Installation & Testing	0	0	0	0	0	847,517	847,517	847,660	0	(143)	847,517	847,660	(143)
Total Project Baseline	1,808,469	1,864,132	1,914,634	55,663	(50,502)	77,116,211	72,905,375	77,557,454	(4,210,835)	(4,652,078)	82,685,143	87,482,046	(4,796,903)
Management Reserve													
Undistributed Budget													
Performance Management Baseline (PMB)	**1,808,469**	**1,864,132**	**1,914,634**	**55,663**	**(50,502)**	**77,116,211**	**72,905,375**	**77,557,454**	**(4,210,835)**	**(4,652,078)**	**82,685,143**	**87,482,046**	**(4,796,903)**